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Status of Atlantic Salmon Stocks in Salmon Fishing Area 19, Eastern Cape Breton Island, 1994

by

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[1]This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

[1]La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

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Abstract

Assessments of the status of Atlantic salmon (*Salmo salar*) in Salmon Fishing Area 19, Eastern Cape Breton Island, derived from angling data, count at the fishway in the Grand River, Richmond Co., and by mark and re-observation counts by divers in the Middle, Baddeck and North rivers Victoria Co. indicated three of the four rivers were under-escaped by 14 to 69% in 1994. Angling effort and catch were lower than the previous year and the 1989 to 1993 mean and may have been affected by a variation order prohibiting retention of grilse (<= 63 cm) and by a drought in July and August. Spawning escapements improved over those of 1993 in the Grand and Middle rivers but were less than required to meet conservation. Spawning escapement to the Baddeck river was 52% less than required. Salmon entry to the North River was delayed during the summer due to low water and reached 255% of spawning requirements by season's end. Reasons for the difference in levels of returns among rivers may be due to differences in marine migration and historical exploitation. Patterns of run timing and river discharge are developing which may allow more options for in-season assessments and allocation of the surplus production of salmon. Based on previous years low returns and unchanged environmental conditions in the North Atlantic Ocean, advice to managers is to proceed cautiously with reduced exploitation and in-season assessments. Further research into target spawning escapements in rivers harbouring anadromous Brook charr (*Salvelinus fontinalis*) is recommended.

Résumé

D'après les évaluations sur l'état du stock de saumon de l'Atlantique (*Salmo salar*) de la zone de pêche du saumon 19 (est de l'île du Cap-Breton) établies d'après les données de la pêche sportive, les dénombrements effectués à la passe migratoire de la rivière Grand, comté de Richmond, et les expériences de marquage-réobservation par des plongeurs dans les rivières Middle, Baddeck et North, comté de Victoria, les échappées de reproducteurs ont été insuffisantes, dans une proportion de 14 à 69 %, dans trois des quatre rivières considérées en 1994. L'effort de pêche et les prises, inférieurs à ceux de l'année précédente et à la moyenne de 1989 à 1993, ont pu être influencés par une ordonnance de modification interdisant de garder les prises de madeleineaux (<= 63 cm) et par la sécheresse en uillet et août. Les échappées de reproducteurs se sont améliorées par rapport à 1993 dans les rivières Grand et Middle, mais ont été inférieures au nombre requis pour la conservation. Dans la rivière Baddeck, elles ont été inférieures de 52 % aux besoins. L'arrivée du saumon dans la rivière North a été retardée durant l'été en raison des basses eaux; à la fin de la saison, on avait atteint 255 % des besoins de reproducteurs dans cette rivière. Les écarts dans le nombre de remontées entre les rivières peuvent être dus à des différences dans la migration en mer et dans l'exploitation historique. Des tendances se dessinent dans la période de montaison et dans le débit des rivières, qui pourraient offrir un plus grand nombre d'options pour les évaluations intrasaisonnières et l'attribution du surplus de production du saumon. Compte tenu des faibles remontées des années précédentes et des conditions environnementales inchangées dans l'Atlantique nord, on recommande aux gestionnaires d'opter avec prudence pour une exploitation réduite et des évaluations intrasaisonnières. D'autres recherches sur les échappées-cibles de reproducteurs dans les rivières où évoluent des ombles chevaliers (*Salvelinus fontinalis*) sont à conseiller.

Summary Sheets

STOCK: Grand River, Richmond Co.
TARGET: 1.1 million eggs, (545 small & large; 234 above Grand River falls)

Year	1988	1989[1]	1990	1991[1]	1992	1993	1994	MIN[3]	MAX	MEAN
First Nations Catch										
In-river			24	39						
Estuarial										
Angling catch										
Small	338	307	416	115	139	113	81	81	416	195
Large	105	74	98	15	46	22	10	10	98	44
Broodstock[2]	33	25	18	19	10	0	7			
Count at fishway										
Small	554	512	527	234	114	91	64	64	527	257
Large	31	25	27	18	18	5	5	5	27	16
% Hatchery			43	45	38	45	14	14	45	37
Fish which by-passed the fishway										
Small	55	51	52	176	40	32	96	32	176	74
Large	54	19	20	14	14	4	9	4	20	13
Population estimate above fishway	694	607	626	442	186	132	173	132	626	361
% Caught and retained above		42	31[4]	31[4]	31[4]	31	0			
Estimated escapement above fishway		453	455	348	133	97	166	97	455	275
% of Adult salmon required										
above falls		194	194	149	57	41	71	41	194	118
entire river		83	83	64	24	18	31	18	83	51

[1]In-season variation closures.
[2]Broodstock taken above or at fishway.
[3] Min, Max and Mean for the period 1989-1994.
[4]Based on 1990 phone survey.

Harvests: There was no legal retention of grilse or salmon in the angling fishery in 1994.

Data and assessment: The falls 10.2 km from the head of tide is a partial barrier. A trap in the top of the fishway has been operated since 1988. Collections made above the fishway in October have been used to estimate the by-pass rate in 1989, 1991 and for grilse in 1994. Phone surveys conducted in 1989 and 1990 to estimate proportion angled above. Fluvial area above is $2.33*10^6$ m^2 and below is $3.1*10^6$ m^2.

State of the stock: There is no consistent estimate for below the falls and escapement above is expressed relative to the entire production

STOCK: Middle River, Victoria Co.
TARGET: 2.07 million eggs (470 large, 80 small salmon)

Year	1988	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[2]
First Nations Catch										
In-river					38		15			
Estuarial[4]	45	53	65	127	75	40	0	0	158	61
Angling catch										
Small	52	51	107	27	11	30	31	0	158	41
Large	148	276	197	186	30	44	184	9	276	128
Counts by divers										
Wild										
Small	-	7	53	18	56	2	48[3]	2	56	36
Large	-	323	208	244	211	31	442[3]	31	455	230
Hatchery										
Small	-	5	16	0	0	0	0	0	16	3
Large	-	25	26	10	1	1	0	0	26	8
Proportion covered	-	0.55	0.83	1	0.96	0.55	0.83	0.55	1.00	0.83
Estimated Escapement	-	655	365	272	241	62	475	62	655	283
% of Adults required	-	119	66	49	44	11	86	11	119	54

[1]1974-93 for the Recreational catches and for the period shown for all other ranges.

[2]Average for 1990-94.

[3]Mark-Recapture estimate with 20% tag loss.

[4]Assumed 50% of the Wagmatcook harvest.

Harvests: Native fisheries occur outside the estuary and in-river. About 130 MSW salmon have been allocated to the Wagmatcook Band since 1983. These salmon are traditionally harvested in gillnet fisheries in the Bras D'or Lake adjacent to Wagmatcook. Other Bands have harvested within the river.

Data and assessment: Annual counts of adult salmon are conducted by teams of divers during mid to end October. Counts cover 55% to 100% of the adult salmon holding area of the river. A mark-recapture estimate using diver observations was conducted for the first time in 1994. First Nation catches are as reported by DFO Fishery Officers and Native Guardians. Some electrofishing was conducted in 1994.

State of the stock: Estimates of escapements declined steadily since 1989, were critically low in 1993, and improved in 1994.

STOCK: Baddeck River, Victoria Co.
TARGET: 2.0 million eggs (450 Large, 80 Small)

Year	1988	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[1]
First Nations Catch										
In-river										
Estuarial[2]	44	52	65	128	75	40	0	0	128	60
Angling catch										
Small	36	18	71	51	57	50	21	18	71	45
Large	175	243	182	213	165	105	92	92	243	167
Population estimate										
Wild										
Small							36			
Large							196			
Hatchery										
Small							0			
Large							1			
Estimated Escapement							232			
% of Adults required							48			

[1] 1989-1994 angling catch data.
[2]Assumed 50% of Wagmatcook fishery.

Harvests: Native fisheries occur outside the estuary and in-river. About 130 MSW salmon have been allocated to the Wagmatcook Band since 1983. These salmon are traditionally harvested in gillnet fisheries in the Bras D'or Lake adjacent to Wagmatcook. Harvests within the river are unknown. There was no legal retention of grilse or salmon in the angling fishery in 1994.

Data and assessment: A mark-recapture estimate using diver observations was conducted for the first time on October 19 and 20, 1994.

STOCK: North River, Victoria Co.
TARGET: 0.85 million eggs (200 Large, 30 Small salmon)

Year	1988	1989	1990	1991	1992	1993	1994	MIN[1]	MAX[1]	MEAN[1]
First Nations Catch										
In-river										
Estuarial										
Angling catch										
Small	135	160	268	186	178	69	77	69	268	156
Large	535	395	610	355	550	110	111	110	610	355
Population estimate										
Wild										
Small							138			
Large							354			
Hatchery										
Small							0			
Large							0			
Estimated Escapement							587			
% of Adults required							255			

[1] 1989-1994 angling data.

Harvests: There was no legal retention of small or large salmon in the angling fishery in 1994.

Data and assessment: A mark-recapture estimate using diver observations was conducted on October 17, 18 and 20, 1994.

Introduction

This document reviews the status of Atlantic salmon (*Salmo salar*) stocks during 1994 for Salmon Fishing Area 19. Salmon Fishing Area (SFA) 19 consists of twenty-eight rivers having historically reported Atlantic salmon angling from the Inverness-Victoria county line eastward to the Canso causeway (Fig 1). Atlantic salmon assessments for this area in 1993 were reported by Cutting et al. (1994) and in similar documents listed there since 1987.

Stocks are assessed using angling catches estimated from the Nova Scotia salmon license stub returns; counts at the Grand River Fishway, Richmond Co. ; counts of marked and unmarked fish during snorkel dives of the Middle, Baddeck and North rivers Victoria Co.; and required spawning escapements reported by Amiro and Longard (1990) for the Grand river and by Marshall et al. (1992) for other rivers. New procedures in 1994 included marking a sample of the salmon prior to the assessment dives and sampling at some of the historical electrofishing sites in Middle and Baddeck Rivers.

Based on low spawning escapements in 1992 and expected similar returns in 1993 and meetings with management and stakeholders there was no licensed retention of grilse or salmon in the sport fishery of SFA 19 in 1994. Agreements with First Nations Bands for food fisheries were directed toward the Margaree River, where surplus fish to conservation requirements were expected and to the Bras d'Or Lakes where significant numbers of aquaculture salmon are at large. Variation orders and agreements remained in effect pending outcome of in-season assessment of stock status in the North River and Grand River.

The determination of small and large salmon is based on small being less-than and large being larger than 63 cm or equal-to 63 cm.

Description of the Fisheries

Native Fisheries

First Nations food fisheries included potential harvests from trap nets located in Margaree estuary, the Bras d'Or Lakes at Eskasoni, Chapel Island, and Whycocomagh Bay and by angling in the Bras d'Or Lakes. Harvests were targeted to returns from sea ranching experiments at Christmas Brook Eskasoni, grilse in the Bras d'Or Lakes and aquaculture escapees in the Bras d'Or Lakes. Periodic fisheries utilizing other gear types occurred adjacent to Wagmatcook and Waycobah reserves. Salmon allocations to Native Peoples by Band in SFA 19 were:

Group/Band	No. of Fish	Location
Chapel Island	150 small 26 small 130 large	St. Peter's Inlet Margaree Margaree
Eskasoni	250 small 26 small 130 large	Christmas Brook sea ranch returns Margaree Margaree
Membertou	200 small 26 small 130 large	Bras D'Or Lakes Margaree Margaree
Wagmatcook	100 small 26 small 130 large	Whycocomagh Bay & Bras D'Or Margaree Margaree
Waycobagh	225 small 26 small 130 large	Whycocomagh Bay & Bras D'Or Margaree Margaree

Commercial

The commercial salmon fishery, shortened in 1983 and closed in 1984, remained closed in 1994. No commercial salmon fishing licenses remain in SFA 19.

Angling

The salmon angling season was June 1 to October 25 through-out most of SFA 19. September 30 closures applied to nine listed rivers between Sydney, Cape Breton Co. and St. Peters, Richmond Co. Season retention of salmon (> 63 cm) and grilse (< 63 cm) was varied to 0 for SFA 19.

Conservation requirements

Target spawning escapements required to meet conservation for rivers of SFA 19 were reviewed by Marshall et al. (1992). Requirements were based on air photographic measurement of fluvial area and 2.4 eggs m^{-2} for reaches with stream gradient greater than 0.12%. Biological characteristics used to derive the adult requirements were based on archival data where available and the most proximate data where none was available. Requirements for the rivers assessed in this document were:

	Grilse	Salmon
Grand	440	100
Middle	80	470
Baddeck	80	450
North	30	200

The required escapement for Grand river was amended in 1989 to 545 total fish based on the complex mixture of repeat spawning grilse in the developing record of ages sampled from the fishway trap (O'Neil et al. 1989).

Fishery data and analysis

Native Fisheries

SFA 19 harvest of salmon was reported from Whycocomagh Bay. A total of 118 salmon was estimated to have been harvested in the bay. Two salmon, both aquaculture escapees, were recorded in the monitoring-harvest trap in the bay.

Fishery Officers report 15 salmon harvested in Middle River, Vic. Co. after October 20, 1994.

Angling

Preliminary estimates of the Atlantic salmon sport catch and effort for SFA 19 indicated that effort fell to 2285 rod days in 1994 down 58% from 1993 and down 69% from the 1989-93 mean (Table 1). The number of released grilse decreased to 231 grilse from the 390 grilse retained and released in 1993. The catch of grilse was 40% below the 1993 catch and 59% below the 1989-93 mean. The number of released salmon was 458 which was a 7% decrease from the 1993 catch and a 56% decrease from the 1989-93 mean. Catches were likely affected by a drought experienced in July to September months (Fig.2)

Research data and analysis

Grand River, Richmond Co.

The trap in the Grand River fishway was operated from June 20 to October 14, 1994. Cumulative counts rose quickly relative to previous years until the first week in July when the drought began (Fig. 2). A total of 64 grilse and 5 salmon was counted and marked at the Grand River falls fishway including 9 hatchery grilse (Table 2). Two marked grilse and four unmarked grilse were observed in broodstock collections above the falls on October 12 and 13, 1994. These data indicate about one third of the grilse used the fishway to ascend the falls. Based on this by-pass rate for grilse and that previously established for salmon >63 cm (0.57) the estimated escapement above the falls was 173 fish which is a 31% increase from the 1993 estimate (Summary sheet 1). A substantial portion of this increase is due to the non-retention of grilse angled above the falls (about 40% of the total grilse catch). The escapement of 166 fish above the falls is 31% of the spawning requirement of 545 fish for the entire river and 73% of the requirement above the falls. Fluvial area above the falls is $2.3*10^6$ m^2 and $3.1*10^6$ m^2 below the falls. Spawning escapement is again less than both that required to seed either the area above the falls and that required for the entire river (Fig.4).

Middle River, Victoria Co.

Electrofishing

Sampling and population estimation by electrofishing was conducted at 15 of 18 potential sites (Fig. 5) where densities were obtained in 1977,1978 or 1985. Sampling at most sites consisted of three-sweep removal estimates in un-barriered sections as was conducted in 1977 and 1978. Three main river sites utilized barrier nets. Estimates of population abundance for both the Middle and Baddeck rivers were derived from Junge and Libosvarsky's (1965) exact solution for three sweeps and by an iterative solution to Zippin's (1956) maximum likelihood technique for four or more sweeps. Population estimates were factored to 100 m^2 units for comparison of population densities by species and by size and age class where length frequency and scales for age determination data were available.

Graphic comparison of the fifteen sites sampled in 1977 with the same sites sampled in 1994 indicated that all parr (age 0+, 1+ and 2+) combined densities increased at most sites in 1994 (Fig. 6). However, where data for each age group are available (at the Findlayson site in the main river) age-1+ and -2+ parr were present (albeit at reduced densities) but age-0+ parr were all but absent from the site (Fig. 7).

Density estimates of Brook charr (*Salvelinus fontinalis*) are also available for six sites in the Middle River and tributaries. Marked decreases in populations of Brook charr were noted in five of the six sites (Fig 8).

Adult salmon counts

Counts of adult salmon and grilse by snorkel diving have been conducted in the main river since 1989. Counts were usually conducted in mid-late October by teams of divers assigned to sections of the main river. The main river is partitioned into six sections (Fig. 9). A dive team (two persons) drifts its section and independently counts salmon and grilse. Swim-thru counts were repeated if major discrepancies occurred between diver observations in each pool or run.

In 1994 the diver count indexing technique was calibrated with a mark and recapture estimate. Marks, plastic streamer tags (Floy Tagging Co. model FTSL 73) were attached through the dorsal fin to 17 salmon captured by drift-netting at two locations in the main river on October 16 (Table 3). A total of 311 un-marked salmon and 13 marked salmon and 35 grilse was observed in six sections on October 17. This number of marks and recapture observations using a Bayesian technique from Gazey and Staley (1986) for single mark and recapture indicated a median population of 442 (276-614, 5^{th} and 95^{th} percentiles) salmon. Accounting for the proportion of grilse in the observations resulted in a total population of 490 fish. These data indicate that there was a 60% chance there were less than 470 salmon in the river on that date. This estimate indicated an observation efficiency of about 74%. If a tag loss of 20% were assumed, then the estimate would drop to 419 fish. Because no evidence of tag-loss or mortality was known, estimates derived from the complete data were used for assessment.

Accounting for in-river removals after the count had been conducted, indicated a population of 475 fish or 86% of the required spawning escapement (Summary sheet 2). This estimate indicated increased spawning escapement relative to the last four years (Fig. 10) without adjustment for an observation rate of fish by divers.

Baddeck River, Victoria Co.

Electrofishing

Sampling and population densities were determined at six of thirteen sites electrofished in 1977 and 1978. Graphical comparison of densities of combined age-0+,1+ and 2+ parr indicate increases at 4 of the 6 sites fished in 1994 (Fig.11).

Brook charr densities on the other hand were low at 5 of the six sites and similar to 1978 levels (Fig.12).

Adult salmon counts

Counts of adult salmon and grilse were conducted by swim thru snorkel diving in two sections of the Baddeck river in 1994 (Fig. 13). Marks, orange ribbon tags, were applied to six salmon in the upper section (A to B on Fig.13) on October 19, 1994. On October 20, 1994, 32 salmon 6 grilse and 6 orange tagged salmon were observed in the upper section (Table 4). These numbers of marked and observed salmon result in a median estimate of 55 (26-151, 5th and 95th percentile) salmon in the upper section using the Bayesian approach.

In the lower section (B to C on Fig. 13) marks, yellow ribbon tags, were applied to four salmon; one grilse and one aquaculture escapee on October 19, 1994. On October 20, 55 salmon and 11 grilse were observed by snorkel diving in section two. Three yellow tags were included in these observations. Pooling the counts resulted in an median estimate of 167 fish (66-299 5th and 95th percentile)(Table 3).

Because no tag loss or mortality was observed, estimates were based on the complete data. In the upper section all tags were observed and all were applied to salmon therefore the estimate of 55 salmon and 10 grilse (adjusted for the proportion of grilse in the sample) was used. In the lower section the combined estimate of 167 fish was used. The total escapement was estimated at 232 fish or 48% of the required spawning escapement (Summary sheet 3).

North River Victoria Co.

Adult salmon counts

An in-season assessment of returns was conducted by marking 10 salmon at MacLean's pool (Fig. 14) on July 13, 1994 (Table 5) and counting salmon and grilse between MacLean's Pool and the bridge at Hwy. 19 on July 14. A total of 59 fish including 34 salmon, 17 grilse and 8 tagged salmon was observed. Marked fish were distributed from MacLean's Pool (B on Fig. 14) down-river to Carey's Rock Pool (the top of the canyon section, mid-way in section C-D on Fig. 14) No salmon were observed below this point in the river. The high rate of re-observed salmon (80%) and the low count indicated a probability of 0.001 percent that there was greater than 200 salmon in the river. Based on this assessment no retention fisheries were initiated.

An assessment of the spawning escapement was conducted by applying tags to 20 salmon and 2 grilse in MacLean's Pool on October 17, and conducting snorkel dive counts on October 18 and 19. No yellow tags, applied July 13, 1994 were observed on October 18 or 19 , 1994. A total of 235 fish including 159 salmon 70 grilse and 8 tagged salmon was observed by divers on October 18 and 19, 1994 (Table 5). These numbers of marked and observed salmon resulted in an estimate of 422 salmon and 165 grilse at the observed salmon to grilse ratio. The probability that the spawning escapement of 200 salmon was not met or exceeded was 44% or 0.44. If a tag loss of 20% had occurred there was a 3.2% chance that the escapement was not met. These data indicate that escapement was 255% of the required spawning escapement (Summary Sheet 4).

Assessment Results

Three of the four rivers assessed in SFA 19 showed substantial deficits in spawning requirements. No verifiable independent assessment methodologies were used to support the assessments. Stakeholders were involved in most aspects of the assessments and, accepted the procedures and when presented with the results, accepted them. Differences between returns and requirements were so great that errors associated with parameters used to establish the requirements or, in some cases returns were not relevant to management advice. Further documentation of stock parameters would shore up the estimates of requirements but not likely affect advice to management because of the resolution level offered. Management and stakeholders do not seem to want to adjust to the last 10 fish.

The acceptance of diver counts was extended and confirmed with the inclusion of more DFO employees, Native people, enforcement

Officers and anglers. The generally high rate of re-observation and the high actual count provided credibility to the estimates. Adjustment to past estimates of escapement in Middle River was not done at this time because only one value for observation rate was available. It was noted that adjustment to the 1994 rate would not affect any year in relation to the spawning target.

Because observation of marked salmon by diving is a relatively recent application of the mark/recapture technique a review of the conditions for justified application of the single-census mark-recapture method is warranted. The conditions are listed and reviewed by Ricker (1975, p. 81) and in summary are:

1. Marked fish suffer the same mortality as the unmarked.
2. Marked fish are as vulnerable to the fishing (sampling) as unmarked fish.
3. Marked fish do not lose their mark.
4. Marked fish become randomly mixed with unmarked.
5. All marks are recognized and reported.
6. Recruitment is negligible during the recovery period.

Review of conditions as applied:

1. In this application no known tag loss or mortality occurred and in one incidence all tagged fish were subsequently observed.
2. Divers did not observe different behaviour between tagged and untagged salmon. Possible negative bias in the estimate may occur because tagged fish are more observable than untagged fish. This bias is minimized when large numbers of untagged fish are observed.
3. While high re-observation rates were obtained, at least two cases in the Middle River were noted where salmon had tags in their mouths. This may have been the result of nipping the tag from the fin of a tagged fish or picking up spoiled tags discarded when applying the tags.
4. Although fish were marked at single or at two locations, re-observations were not usually clumped and were distributed over wide areas. It is difficult to determine whether tagged fish moved outside the surveyed area at a greater rate than untagged fish.
5. Divers reported no problems identifying a tag on a salmon or differentiating between tags and foul hooked and lost salmon (carrying a fly). Identifying small Carlin tags was less consistent.
6. Recruitment was limited to less than 6 hours, the duration of the sampling count.

In the opinion of the dive team, which included two knowledgeable and experienced technicians, and two biologists, no known breaches of the conditions for justifiable application of the technique were observed. While it is difficult in any population census to ensure no bias in the data, positive bias in the estimate is particularly sensitive to conditions 1 and 3, because so few fish are tagged. The high re-observation rates indicate that further testing of the tag loss and mortality assumptions would not alter the estimates substantially. If tagged fish are more readily seen than untagged fish then estimates may be negatively biased. It is assumed that random error associated with any of the conditions is adequately captured by the estimator. Transportability of observation rates derived here is not valid based on only the three experiments conducted here. Water clarity, population size and density, river width and velocity, and substrate configuration all contribute to the ability of divers to see fish which impacts on the re-capture (re-observation) rate.

Ecological considerations

Discharge in Grand River was low during July and August 1994. Discharge was not as low as that experienced in 1991 when June discharges were not sufficient to initiate entry of salmon into the river. The low July and August discharges did affect delayed entry to the fishway in 1994. Evidence is mounting that about 2 cubic meters per second (cms) is required to initiate the run and that cumulative catches in years with discharges greater than 2 cms may be used to forecast the total return during the season (Figs. 2 & 3).

While precipitation events in the North River area are not exactly the same as those of Grand River they were close in 1994 and the response of the salmon was also similar. A few salmon entered the North River early and the in-river population remained low until the September rains. This fact was born out in the in-season assessment. Conditions such as occurred 1994 and 1991 reduce the effectiveness of in-season assessments as tools for input to in-season management adjustments. Only consistently high returns or reliable forecasting models can alleviate this situation.

Environmental conditions in the North Atlantic did not appreciably improve for salmon in 1994. The March index of marine habitat for Atlantic salmon, a significant variable in marine abundance models, showed little increase. (ICES Working Group Report Assess:16 Ref.:M). The group noted a greater than random occurrence in recruit/spawner ratios less than replacement in recent years in all North American stocks of salmon except for Gulf of St. Lawrence two sea-winter stocks. This is particularly important in view of the closed commercial fisheries along most of the migration route. Based on the returns in 1992 and the continuing trend in marine survival recorded in hatchery stocks throughout SFA's 19 to 23 (Cutting et al., 1994) and the marine conditions reported in 1993, a cautionary message was conveyed to management for 1994. This message called for reduced exploitation during the early return period and re-evaluation of stock abundance during mid-season.

Brook charr densities are included in this assessment because in the Victoria Co. rivers and especially those flowing into the Bras d'Or Lakes, brook charr occupy considerable habitat and compete with Atlantic salmon. Brook charr in these rivers show considerable anadromy and attract much attention in the sport fishery. Fall diver counts of salmonids do not usually encounter many brook charr because of the lateness of the dives. When diving was first used to assess the success of returns of early-run hatchery salmon in Middle River considerable numbers of brook charr were observed in September but were not observed in October. These charr were thought to have ascended to the upper reaches of the river and tributaries and were spawning or post spawning at the time the fall counts of salmon were being conducted in the main river. This observation may be relevant to the calculation of spawning escapement requirement of salmon. The required egg density per unit area assumes even distribution of salmon over all habitat and no habitat separation based on species competition. Requirements derived this way for Middle River result in numbers of salmon usually in excess of the total population. The population may have been limited by insufficient stock or lower than normal marine survival. If population has been limited because of low escapement, then increased populations can be expected. Monitoring the remote reaches of the river system to document the colonization (or lack of) by salmon would support or question the distribution assumption in the estimates of required spawning escapement.

Forecasts/Prospects for 1995

No existing relationships between first and second recruits stand in SFA 19 and no new relationships were tested. The possibility of uncovering significant predictive models may increase with stability in fisheries and data reporting. Because of the high variation in fisheries and environment, forecasting from mean catches, exploitation and/or stock and recruitment models will require rigorous statistical analysis before useful forecasts can be provided for use by managers.

Little explanation is offered for the difference in returns between Gulf and Atlantic coast stocks other than the possibility of variance in migration and effects of closed commercial fisheries. Based on the returns to three of the four stocks assessed here, the generalized decline in catch in both the recreational and Native Peoples fisheries and the marine habitat index measured in March 1994, there seems little reason to deviate from the interpretation of 1993 for the Atlantic side of Cape Breton Island.

Management considerations

Subsequent assessments in North River might provide reason to treat North River separately from other SFA 19 rivers. Fall assessments have been attempted in North River since 1990 but were prevented by high water conditions. In five of the past seven seasons water levels were high enough to allow summer entry of salmon to North River. In-season counts of salmon together with detailed timing of catches from past seasons could allow in-season forecasts of total return. These would be of some benefit to managers for allocating a harvest or opening a fishery. Years like 1991 and 1994, with prolonged summer droughts, cannot provide forecasts of total returns unless discharge were a significant variable in the model. This fact, together with an unresolved knowledge of the fall-run component, will sometimes leave managers with an undetermined stock status and lead to unallocated surpluses. One possible way to overcome this dilemma would be to operate trap nets in St. Ann's Bay. These nets would take advantage of the similar arrival time of all salmon, historic catch data and possible development of a catch per-unit of effort forecast of returns. Such a fishery could be terminated, based on poor CPUE, before exploitation exceeded the conservation target.

Acknowledgements

This report would not have been possible without the assistance of the First Nations People of Eskasoni, Wagmatcook, Waycobah, Membertou and Chapel Island Bands. Services of their Fishery Guardians were essential in the collection of the electrofishing data and

greatly appreciated in their support of diving operations. Conservation and Protection personnel of DFO assisted in many facets of field operations. The support by members of the Bras d'Or Wildlife Association was greatly appreciated in the North River dives. We thank Ms. D. Glass for typing the summary tables. Thanks to M. Sinclair, G. Stevens, R. Jones, J. Cameron and S. O'Neil, DFO, Halifax, for participating in the dive operations. We are appreciate all of their efforts.

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Table 1. Atlantic salmon sportcatch and effort for Salmon Fishing Area 19, 1993 and 1994, contrasted with mean catches, 1989-93.

	1994 Preliminary				1993				1989 - 93 means							
	Grilse		Salmon		Grilse		Salmon		Grilse				Salmon		Effort	
River	retained	released	released	Effort	retained	released	released	Effort	retained	95% C.I.	released	95% C.I.	released	95% C.I.	rodtrips	95% C.I.
Salmon Fishing Area 19																
Aconi Brook									6.5	6.5	1.3	2.4	8.3	7.1	38.0	25.0
Baddeck	1	16	62	314	33	15	108	785	31.8	19.4	16.8	12.1	183.0	64.9	638.6	139.5
Barachois	0	1	7	53	8	2	25	150	5.0	2.5	2.8	3.9	16.2	11.2	98.2	43.2
Catalone	0	0	0	5	1	0	1	73	14.2	16.5	1.2	1.4	8.2	10.2	293.4	238.5
Clyburne	0	0	10	24	0	0	0	2	1.0	2.5	0.0	0.0	1.0	2.5	20.0	25.1
Framboise	0	0	0	62	6	2	0	202	31.0	33.6	5.0	3.4	20.6	23.5	342.2	127.5
Gaspereau: Cape Breton Co.	0	0	0	16	0	0	0	8	0.8	1.0	0.0	0.0	0.2	0.6	23.6	22.2
Gerratt	0	0	0	4	0	0	0	7	1.2	2.0	1.4	3.2	0.2	0.6	20.0	19.7
Grand	0	69	21	409	118	21	25	1494	201.2	128.7	29.0	34.5	52.6	43.4	2193.8	710.5
Indian Brook	0	0	1	11	2	3	1	43	1.4	1.4	2.4	4.2	7.4	13.7	40.6	37.4
Ingonish	0	3	8	50	16	7	22	128	8.6	7.2	1.8	3.7	13.0	12.8	94.4	55.8
Inhabitants	0	24	64	164	25	0	81	311	30.6	8.2	3.4	5.5	108.2	38.6	399.4	83.5
Little Lorraine									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lorraine Brook					2	0	1	38	8.0	8.2	1.8	1.6	4.0	4.8	100.6	85.7
MacAskill's Brook					0	0	1	9	0.3	0.6	1.5	3.7	2.5	5.4	18.5	38.8
Mario Joseph	0	1	13	64	0	0	0	90	10.4	14.2	0.6	1.7	1.6	2.6	86.8	49.1
Middle: Victoria Co.	0	24	147	483	25	5	48	406	34.4	35.0	11.4	12.1	148.0	131.6	670.2	421.2
Mira	0	8	3	51	0	1	0	87	10.6	10.9	1.2	2.0	8.0	9.2	196.6	112.4
North Aspy	0	13	29	68	2	0	9	48	4.2	4.2	0.6	1.1	22.4	15.3	84.4	35.1
North: Victoria Co.	0	69	93	405	62	19	162	1247	143.6	68.5	40.6	20.8	415.4	218.7	1534.2	358.6
Northwest Brook (River Ryan)					0	0	0	9	0.3	0.6	0.0	0.0	2.5	6.2	23.8	22.6
River Bennett									1.0	N/A	0.0	N/A	1.0	N/A	6.0	N/A
River Denys					0	0	0	2	0.2	0.6	0.0	0.0	0.6	1.7	3.2	4.9
River Tillard	0	3	0	8	4	1	3	34	8.2	7.7	1.8	2.0	8.2	5.8	65.0	27.9
Saint Esprit	0	0	0	68	0	0	0	2	0.4	0.7	0.0	0.0	0.2	0.6	10.2	10.6
Salmon: Cape Breton Co.	0	0	0	16	2	0	3	162	6.8	4.1	1.4	2.6	10.4	8.2	277.6	85.7
Skye	1	0	0	7	6	1	0	23	6.0	N/A	1.0	N/A	0.0	N/A	23.0	N/A
Sydney	0	0	0	3	1	0	2	15	0.8	1.6	0.2	0.6	4.4	5.3	14.0	15.4
Totals	2	231	458	2285	313	77	492	5375	561.2		125.8		1044.4		7273.0	22.6

Table 2. Post smolt age, spawning history, number caught, length and weight of Atlantic salmon trapped in the Grand River Falls fishway in 1994.

Post smolt (years)	Caught	Length (cm.)				Weight (kg.)				
		n	mean	min.	max.	sd	n	mean	min.	max.	sd
1	52	52	53.2	48.0	60.0	2.34	52	1.76	1.20	2.70	0.28
1 hatch.	9	9	55.3	53.0	59.0	1.94	9	1.96	1.70	2.20	0.16
2 sp.1	1	1	52.0	52.0	52.0		1	1.80	1.80	1.80	
total grilse	62	62	53.5	48.0	60.0	2.39	62	1.79	1.20	2.70	0.27
2	2	2	73.5	72.0	75.0	1.50	2	3.80	3.50	4.10	0.30
3 sp.2	1	1	74.0	74.0	74.0		1	4.30	4.30	4.30	
total salmon	3	3	73.7	72.0	75.0	1.25	3	3.97	3.50	4.30	0.34

unknowns length 51.0, 53.0 and 58.0 cm. wild and 59.0 cm. hatchery

Table 3. Numbers of salmon and grilse marked and numbers of un-marked and marked fish observed during diver counts in the Middle river Vic. Co. 1994.

Sect.	Date	Salmon	Grilse	Marks observed S	Marks observed G	Totals
Marks applied						
2	16/10	8				
3	16/10	1				
4	16/10	8				
Counts by divers						
1	17/10	27	5	0	0	32
2	17/10	67	9	7	0	83
3	17/10	35	7	1	0	43
4	17/10	109	8	2	0	119
5	17/10	73	6	3	0	82
6	17/10					0
		311	35	13		359

Bayesian Estimates:

Salmon

Marks	Captures	Recaptures
17	324	13

Median	5%tile	95%tile
442	276	614

Grilse @ 0.108 of salmon
= 48
Total = **490**

Assuming 20% tag loss

Salmon

Median	5%tile	95%tile
378	230	594

Grilse @ 0.108 of salmon
= 41
Total = **419**

Table 4. Summary of mark and re-capture information for the Baddeck River, Vic. Co., 1994. Coloured ribbon tags were applied through the dorsal fin and observed while conducting a swim-thru count of salmon. Baysian estimates of populations for the the median, 5 th and 95 th percentile are shown.

Upper Section:

				Marks	Captures	Re-captures
Tagged Oct 19	6	salmon	orange tags	6	44	6
Count Oct. 20	32	salmon		Bayes estimate:		
	6	grilse				
	6	tags	orange tags	Median	5 th	95 th
total	44			55	26	151

Lower Section:

				Marks	Captures	Re-captures
Tagged Oct 19	4	salmon	yellow tags	6	66	3
	1	grilse				
	1	aquaculture				
Count Oct. 20	55	salmon		Bayes estimate:		
	11	grilse				
				Median	5 th	95 th
total	66		3 yellow tags observed	167	66	299

Total River:

Marks	Captures	Re-captures
12	110	9

Bayesian estimate:

Median	5 th %tile	95 th %tile
166	92	295

Assuming 20% tag loss

Median	5 th %tile	95 th %tile
140	77	275

Table 5. Numbers of salmon and grilse marked and numbers of un-marked and marked fish observed during diver counts in the North river Vic. Co., 1994.

Procedure/Section	Date	salmon	grilse	tags observed salmon	tags observed grilse	totals
Tags applied:						
Macleans	13/7	10				10
Counts by divers:						
Macleans to Carey's	14/07	34	17	8	0	59
Tags applied:						
Macleans	17/10	20	2			22
Counts by divers:						
Benchs to Macleans	19/10	51	23	4	0	78
Macleans to Little Falls	18/10	55	17	4	0	76
Little Falls to Head Tide	18/10	53	28	0	0	81
		159	70	8	0	235

Bayesian Estimates:

Salmon

Marks	Captures	Recaptures
20	159	8

Median	5%tile	95%tile
422	238	614

Grilse @ 0.391 of salmon
= 165
Total = **587**

Assuming 20% tag loss

Salmon

Median	5%tile	95%tile
358	194	598

Grilse @ 0.391 of salmon
= 140
Total = **498**

Figure 1. Map of Salmon Fishing Area 19 showing the locations of assessment activity in 1994.

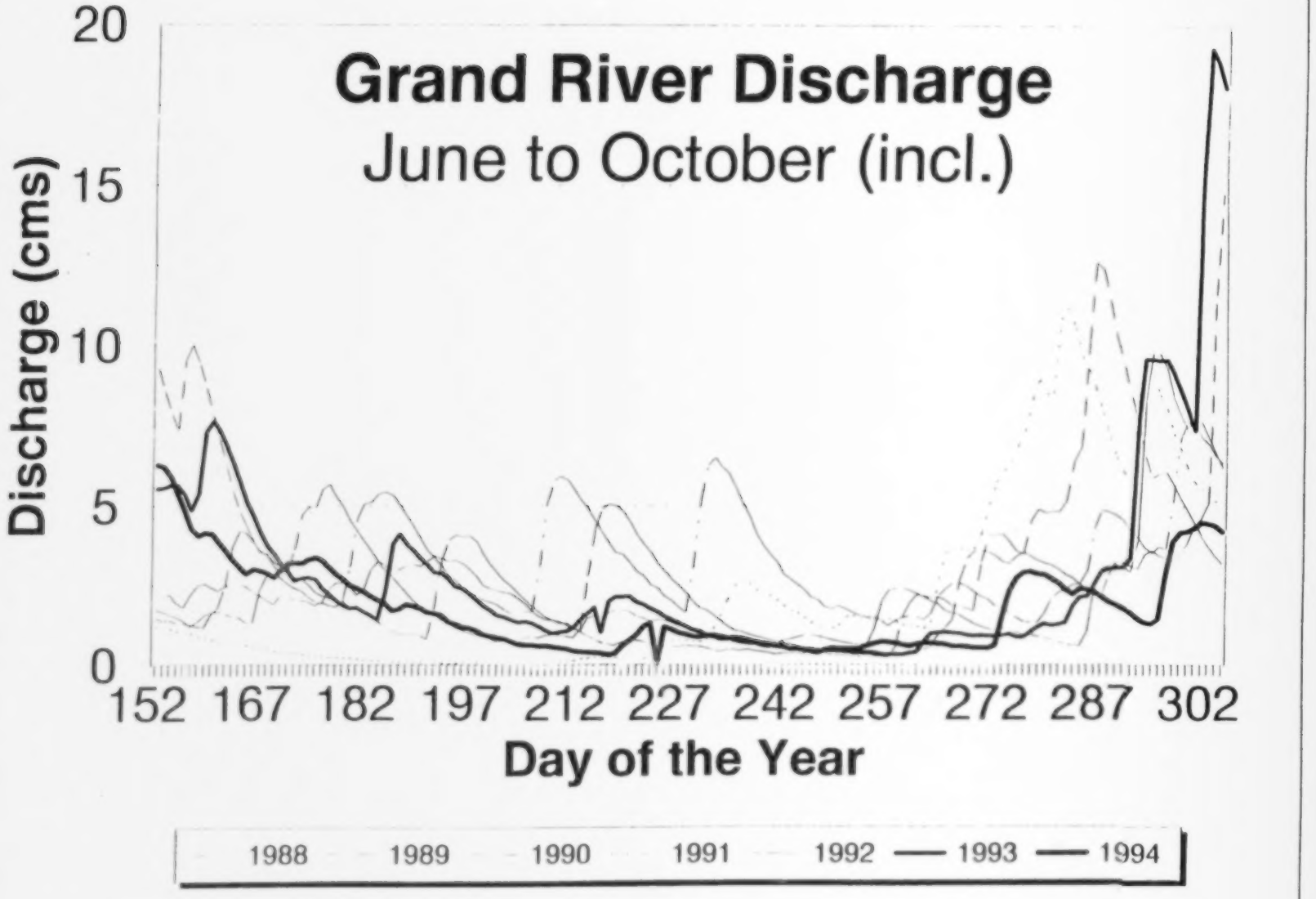

Figure 2. Daily discharge ($m^3 * second^{-1}$) for the water gauging station located below Loch Lomond Lake in Grand River, Richmond Co. for June to July, 1988 to 1994.

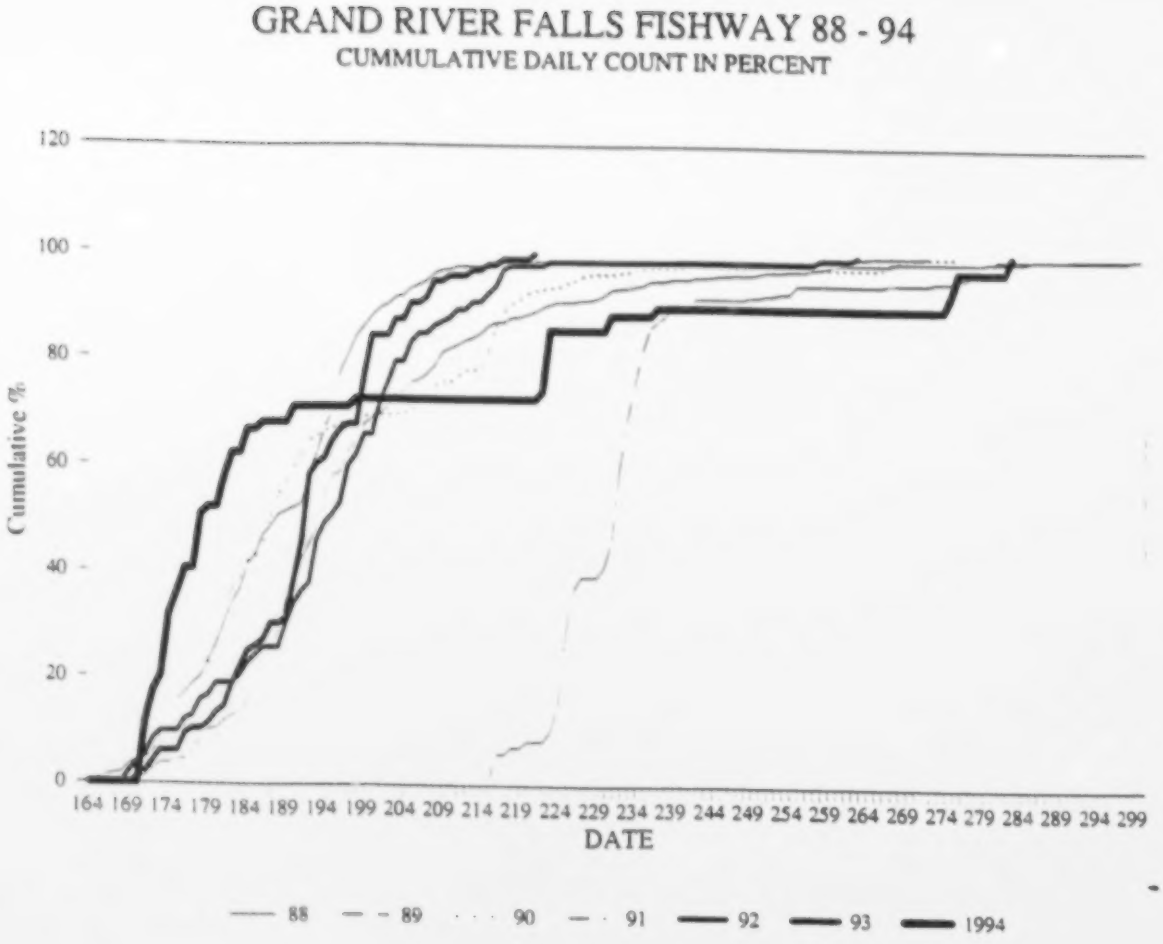

Figure 3. Cumulative percent of the annual total count of Atlantic salmon at Grand river fishway trap, 1988 to 1994.

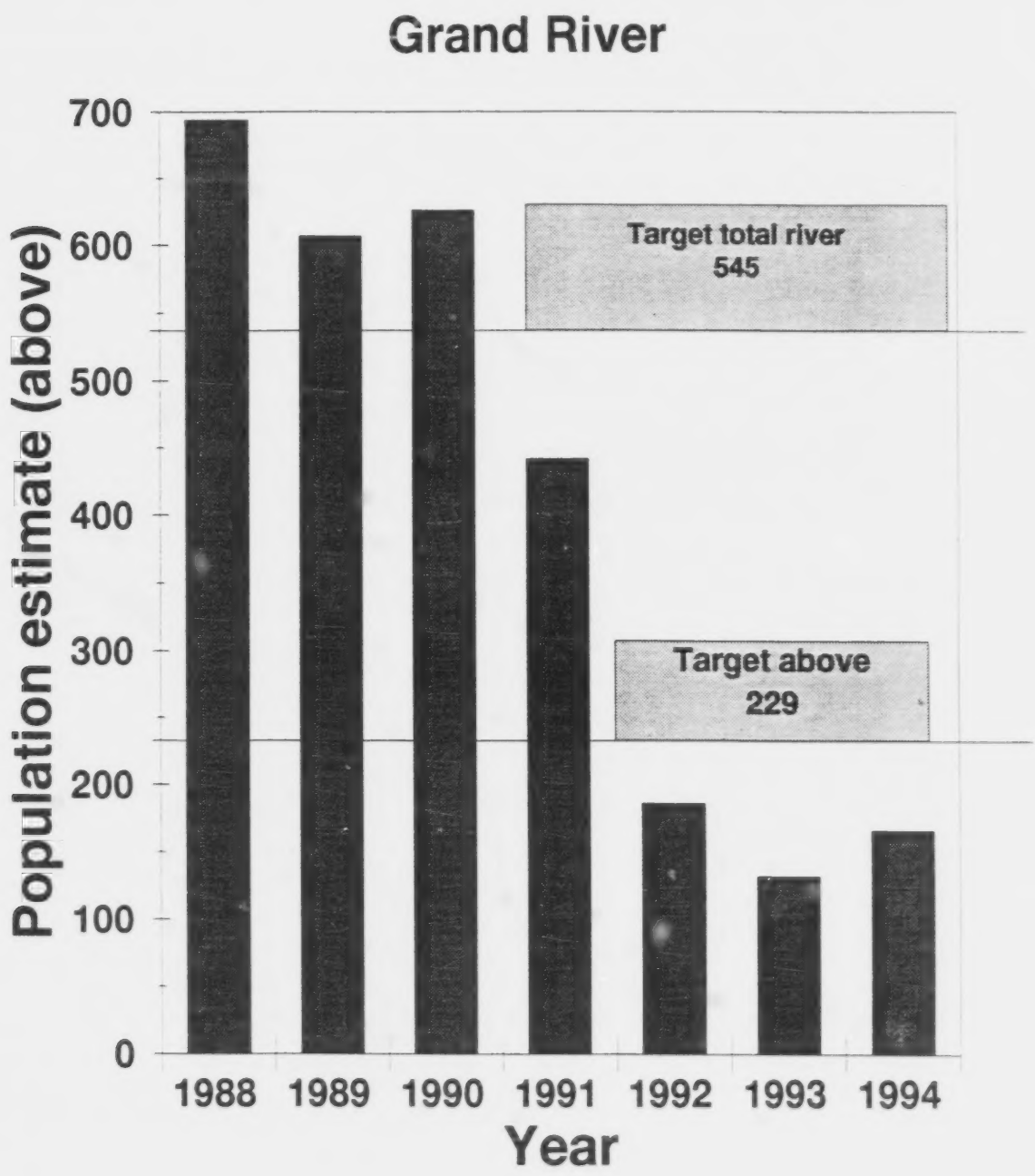

Figure 4. Estimated escapement of Atlantic salmon to above Grand River Falls, Richmond Co. 1988 to 1994.

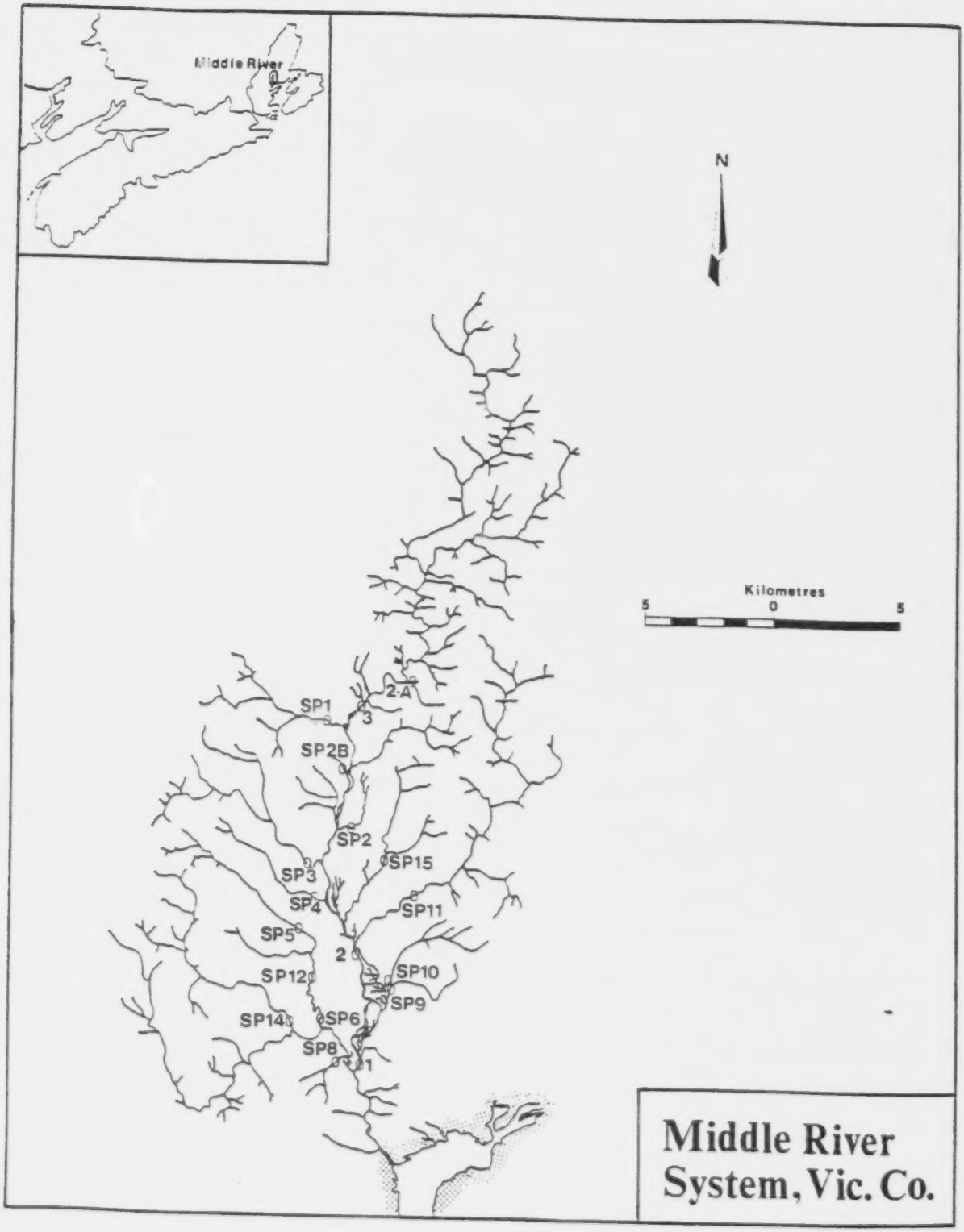

Figure 5. Map of Middle River Vic. Co. showing locations of electrofishing sites .

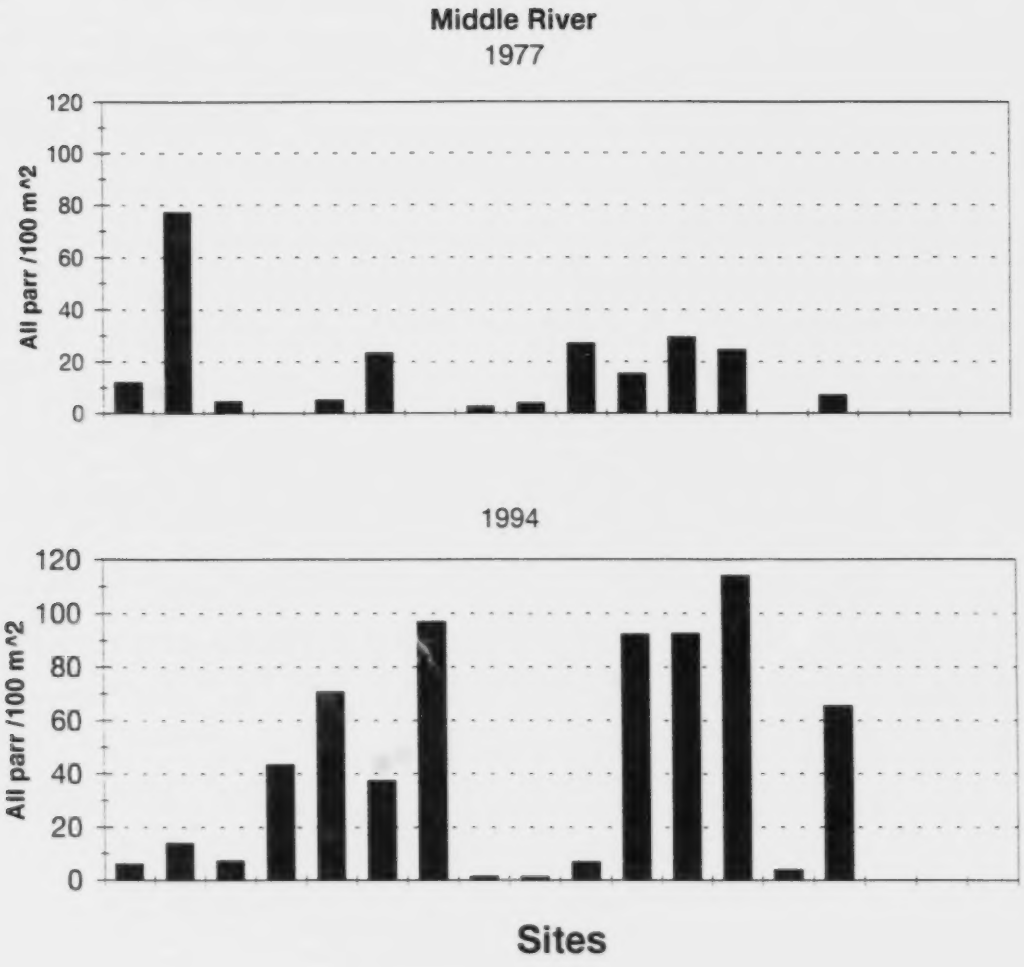

Fig. 6. Density (100^-1 m^2) of combined age-0+,1+ and 2+ Atlantic salmon as determined by electrofishing at 15 sites in Middle River, Vic. Co.,1977 and 1994.

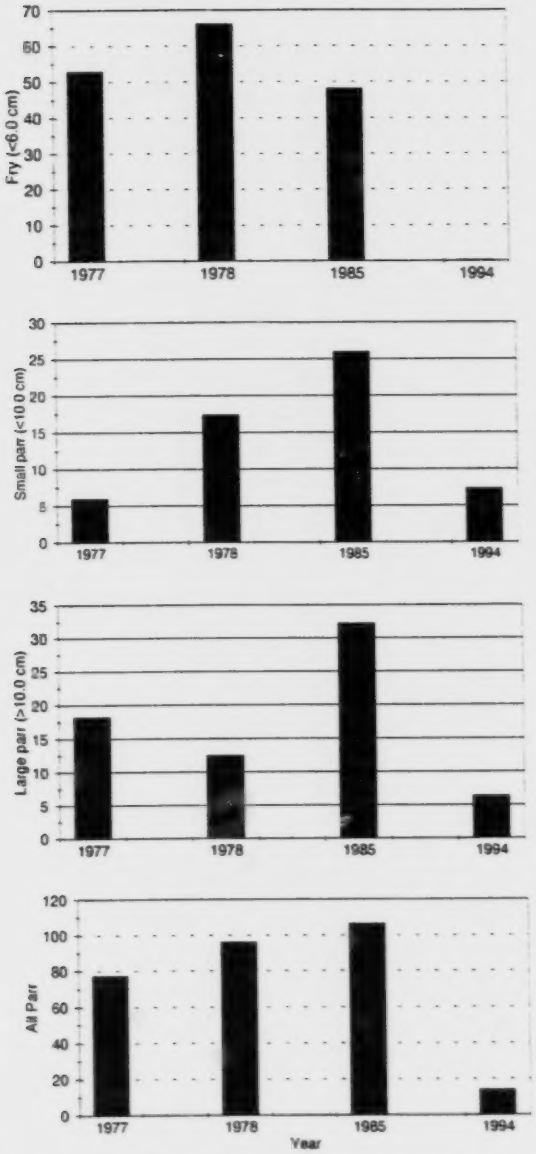

Fig. 7 Density (100^-1 m^2) of age 0+, 1+ and 2+ Atlantic salmon as determined by electrofishing in the Findlayson site in the Middle River Vic. Co. 1977, 78, 85 and 94.

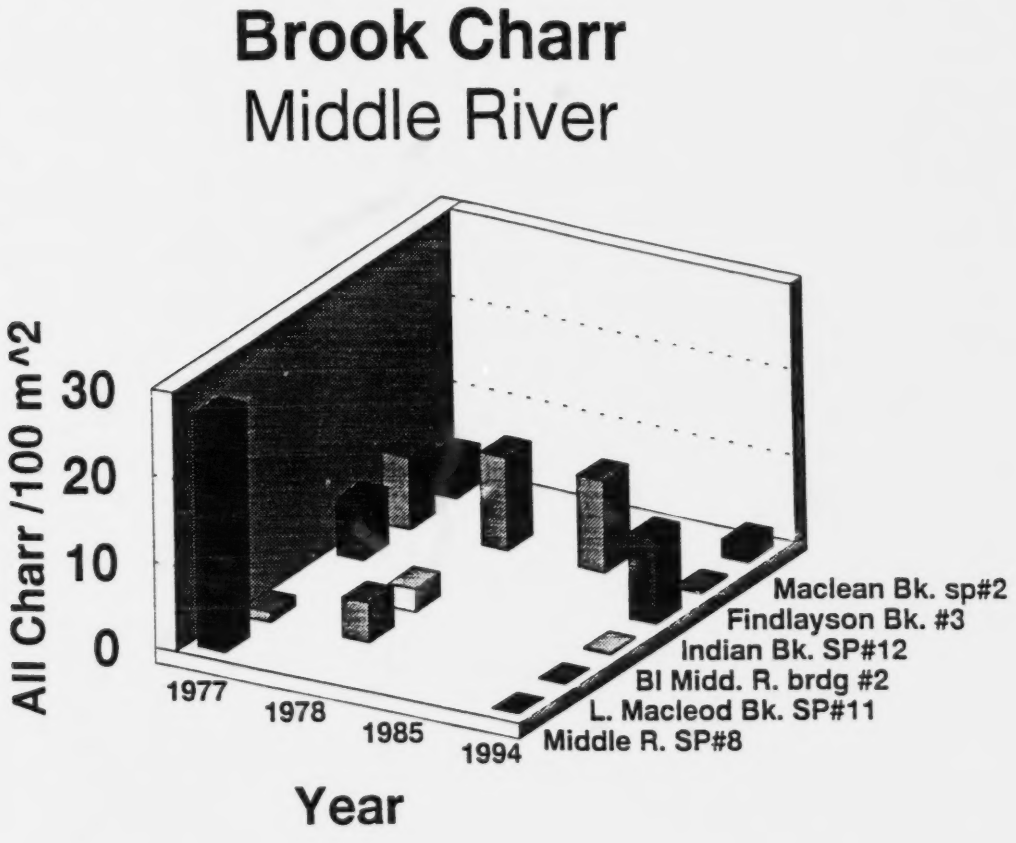

Figure 8. Density (100^{-1} m^2) of all Brook Charr as determined by electrofishing at six sites in the Middle river Vic. Co. 1977 and 1994.

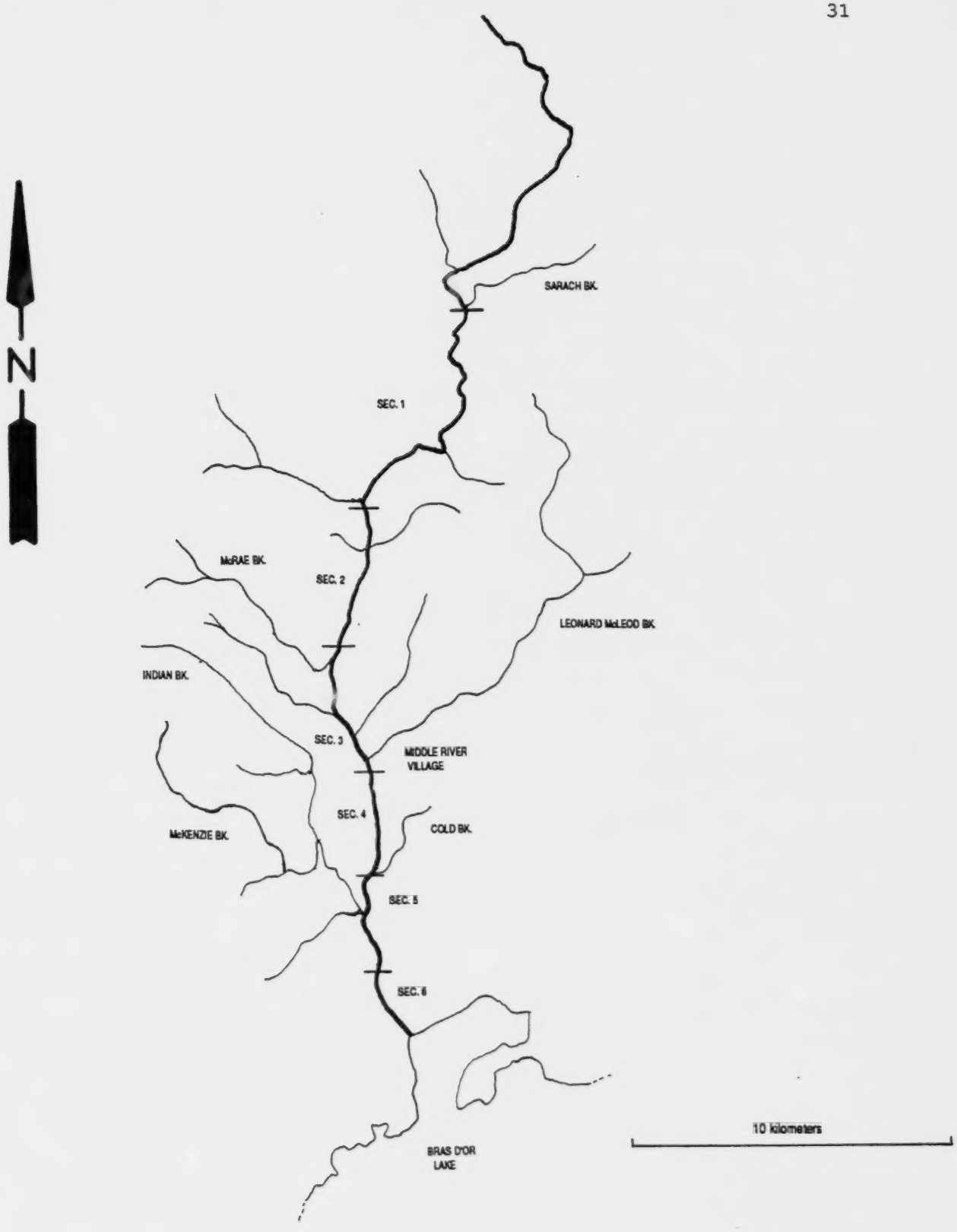

Figure 9. Map of Middle River Vic. Co. showing sections surveyed by snorkel diving for the purpose of counting Atlantic salmon and other adult salmonids.

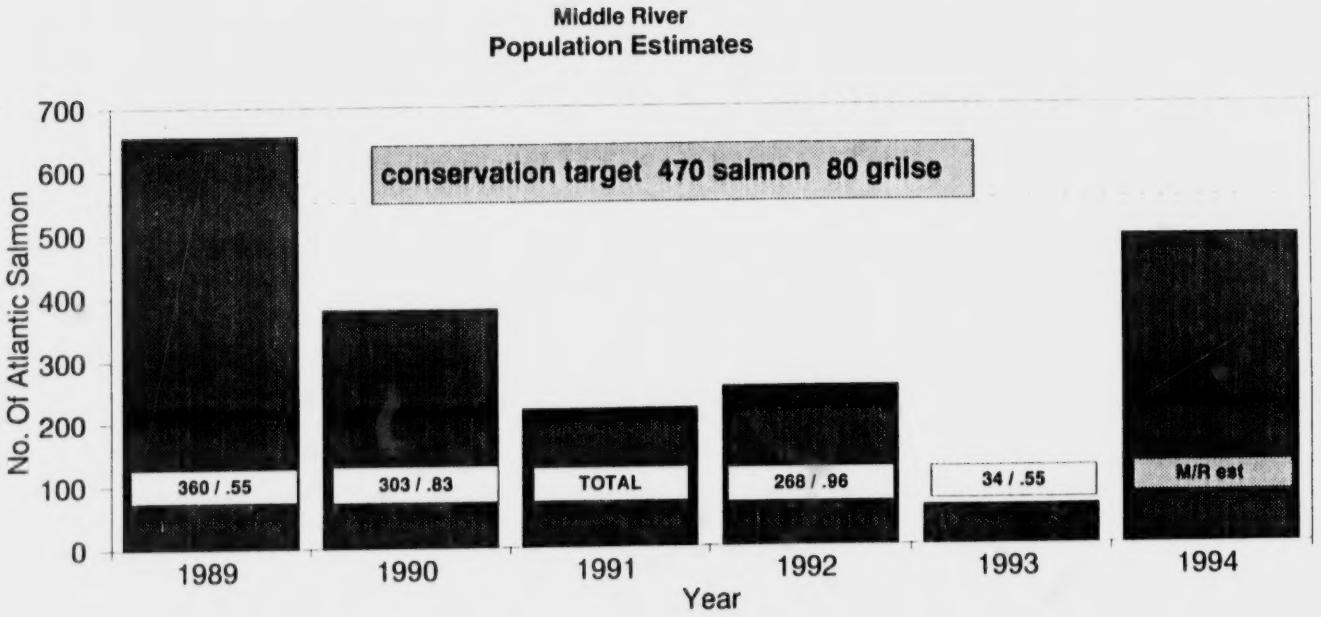

Fig. 10. Fall population estimates of Atlantic salmon in Middle River, Victoria County (inserts are fish counted/ proportion of river swum by divers).

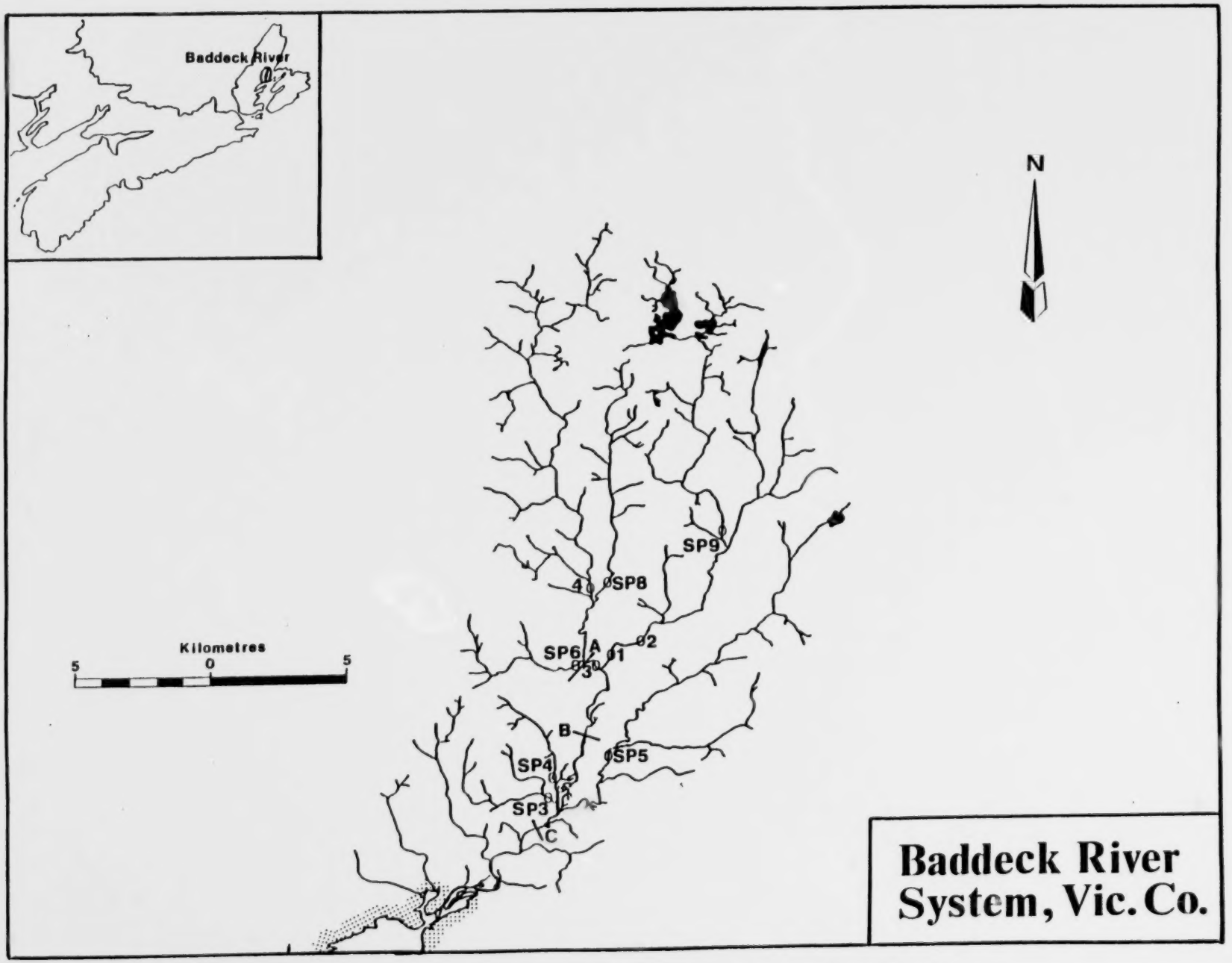

Figure 11. Map of Baddeck River Vic. Co. showing the locations of electrofishing sites and sections surveyed by swim-thru counts of Atlantic salmon by snorkel divers.

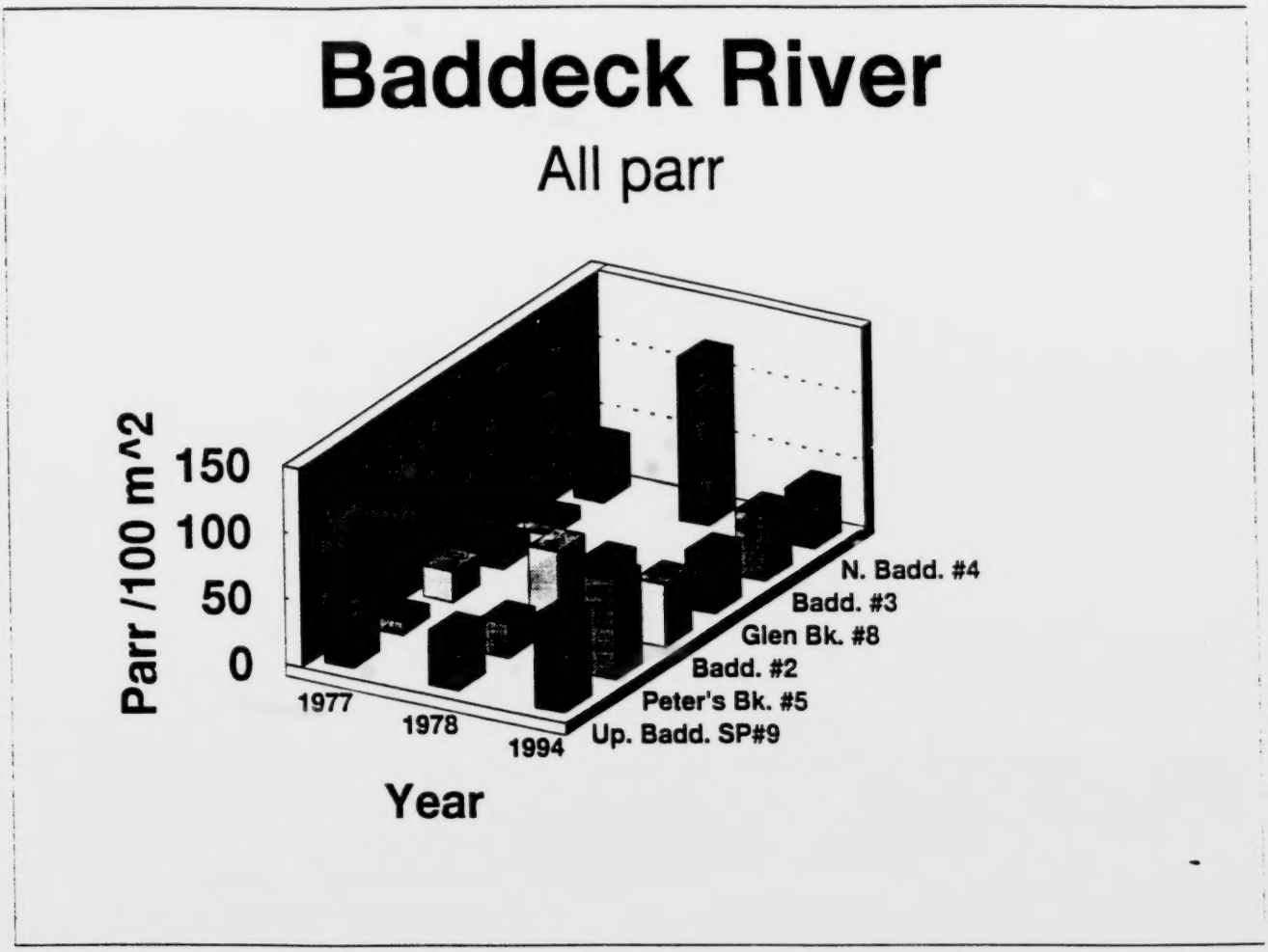

Figure 12. Density (100^{-1} m^2) of combined age 0+.1+ and 2+ Atlantic salmon as determined by electrofishing at six sites in the Baddeck River Vic.Co. 1977 and 1994.

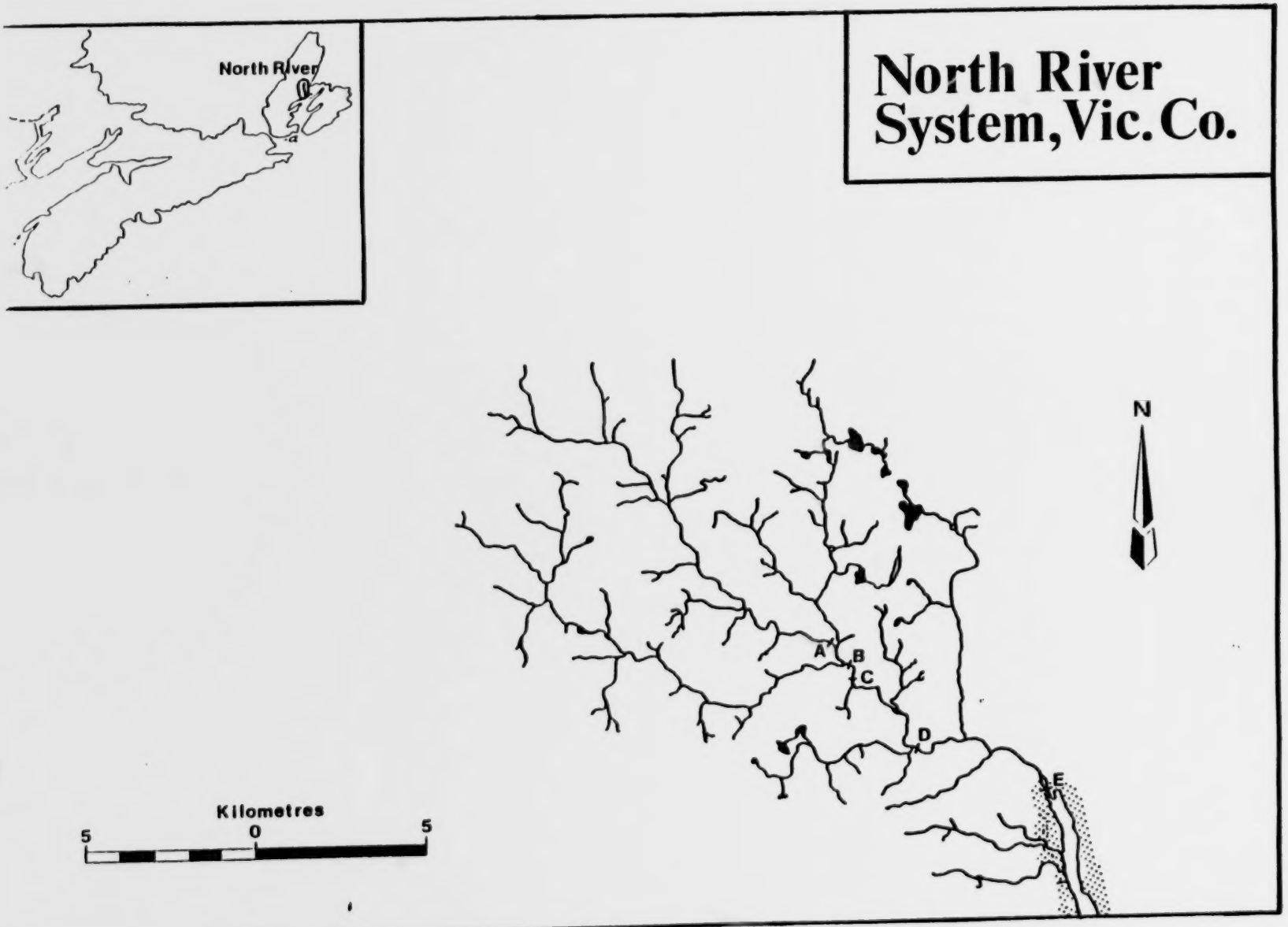

Figure 13. Map of North River Vic. Co, showing sections surveyed by swim-thru counts of Atlantic salmon.